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(54) **Method of processing image information and method of preventing forgery of certificates or the like**

(57) Additional information, composed of characters, images, voice, etc., is converted into two-dimensional codes (step S104) and then converted into a visible additional image to be embedded (step S105). The additional image is embedded in a full-color main image in a state of invisibility to produce a composite image (step S106). The composite image is recorded on a non-electronic medium such as paper or on an electronic medium, such as a memory on a personal computer, over the Internet (step S108). The embedded additional image is extracted from the composite image recorded on the recording medium and the additional information is reproduced (steps S109, S113).

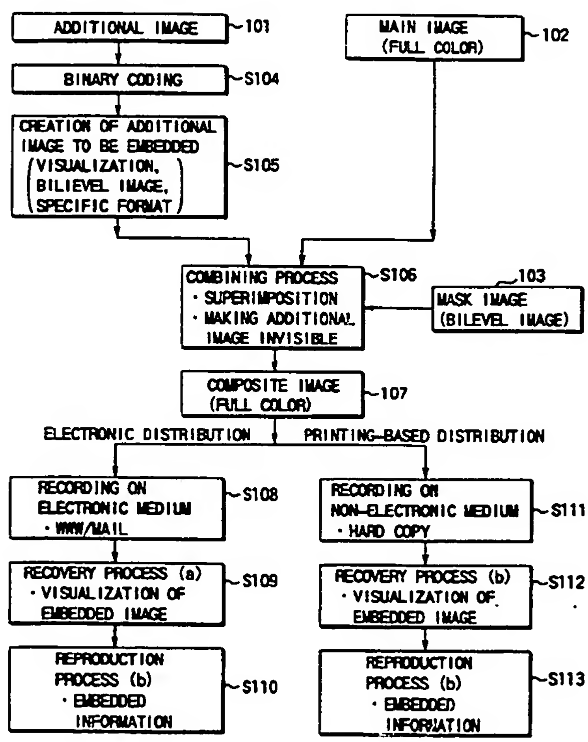

FIG. 1

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based on two-dimensional codes;

FIG. 4 is a diagram for use in explanation of conversion of a to-be-embedded additional image into a bi-level image based on two-dimensional codes;

FIG. 5 is a diagram for use in explanation of conversion of a to-be-embedded additional image into a bi-level image based on two-dimensional codes;

FIG. 6 illustrates the procedure for creating a composite image;

FIG. 7 illustrates an example of a specific computation in the composite image creation procedure;

FIG. 8 illustrates an example of a specific computation in the composite image creation procedure;

FIG. 9 illustrates an example of a specific computation in the composite image creation procedure;

FIG. 10 illustrates an example of a specific computation in the composite image creation procedure;

FIG. 11 illustrates an example of a specific computation in the composite image creation procedure;

FIG. 12 illustrates an example of a specific computation in the composite image creation procedure;

FIG. 13 illustrates an example of a specific computation in the composite image creation procedure;

FIG. 14 illustrates an example of a specific computation in the composite image creation procedure;

FIG. 15 illustrates an example of embedding information in a landscape photograph;

FIG. 16 is a diagram for use in explanation of alignment marks in a composite image;

FIG. 17 shows an example of a bi-level mask image;

FIG. 18 is a block diagram of an image creating and recording system;

FIG. 19 is a block diagram of an image reproducing system;

FIG. 20 is a flowchart illustrating an image information processing method according to a first embodiment of the present invention;

FIG. 21 shows an example of an identity card for explaining a second embodiment of the present invention;

FIG. 22 is a diagram for use in explanation of printing (recording) a face photograph onto an identity card according to the second embodiment of the present invention; and

FIGS. 23A, 23B and 23C each show a relationship between the amount of color difference and data values of a main image in which additional information is to be embedded.

[0016] Referring now to FIG. 1, there is shown a flowchart illustrating an image information processing method according to the present invention. Hereinafter, the image information processing method of the present invention will be described with reference to this flowchart.

[0017] Additional information 101 to be embedded includes characters, images, sound, etc., which are information a creator wants to embed invisibly. A main image 102 is an image in which additional information is to be embedded, such as a photograph of a person's face on an identity card. The main image serves as information for producing a full-color image. A mask image (pattern image information) 103 is two-valued image information which is used in a combining process (step S106) and a recovery process (a) or (b) (step S109 or S112) as will be described later.

[0018] In the first place, in binary coding step S104, the to-be-embedded information 101 is binary-coded (two-valued and coded). In this case, analog data, such as sound, is first subjected to analog-to-digital conversion and then binary-coded. On the other hand, digital data, such as characters and images, is binary-coded as it is.

[0019] Next, in to-be-embedded image creating step S105, the binary (two-valued) data produced in binary coding step S104 is converted into binary image data in accordance with a predetermined format, thereby producing a to-be-embedded additional image. By this process, even data that is usually invisible, such as sound data, is converted into visible data (binary image data).

[0020] Next, in combining step S106, the to-be-embedded image produced in step S105, the main image 102, and the mask image 103 are combined into a full-color composite image 107. The composite image 107, when made visible, apparently looks identical to the main image 102; the additional image is hidden in a state of invisibility. The composite image 107 can be stored in a commonly used format, for example, TIFF or JPEG.

[0021] The composite image 107 thus produced can be distributed via either an electronic medium, such as a home page on the Internet or electronic mail, or a non-electronic medium such as paper.

[0022] First, the distribution of the composite image via an electronic medium will be described. In recording step S108, the composite image 107 produced in combining step S106 is recorded on an electronic medium, such as a home page or electronic mail on the Internet.

[0023] Next, a person who received the composite image recorded on the electronic medium performs a recovery operation in step (a) S109 to make visible the additional image invisibly embedded in the composite image. After that, the recipient performs a reproduction operation in step (a) S110 to reproduce the embedded additional information 101.

[0024] The distribution of the composite image through a non-electronic medium will be described. In recording step S111, the composite image 107 produced in combining step S106 is recorded on a non-electronic medium such as paper.

[0025] Next, a person who received the composite image 107 recorded on the non-electronic medium performs a

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Then, these are replaced with image elements as shown in FIG. 4.

[0032] Further, the bilevel image information is enlarged by a factor of n in order to prevent the degradation of to-be-embedded images during a smoothing step in the combining process to be described later. Here, it is preferable that n = 2, 3 or 4. In FIG. 5 there is shown the result of enlarging the bilevel image information of FIG. 4 by a factor of two.

[0033] Although, in this embodiment, the calra code is applied to the two-dimensional coding, a matrix type two-dimensional code or a two-dimensional bar code, such as the glyph code, can be used.

[0034] After the replacement of all the to-be-embedded additional information with two-dimensional codes, in step S105, these are laid out two-dimensionally to obtain the to-be-embedded images. In this example, as the to-be-embedded image, the header a, the first information b, the second information c, the third information d, and the fourth information e are converted into two-dimensional codes.

[0035] At the time of creation of the to-be-embedded information header and the to-be-embedded information, each piece of to-be-embedded information is related with the main image. This provides a criterion for allowing users to draw certain specific information from multiple pieces of information embedded in a composite image.

[0036] For example, in a case where the present invention is applied to an electronic picture book, suppose that photographs of a zoo are used as main images. Among these photographs, for example, a photograph of lions will be associated with their cries and a photograph of penguins will be associated with their ecology. Thus, if a main image and embedded information are related so that the main image can be relatively easily associated with the embedded information, then it will become easy for users to find desired one from multiple pieces of embedded information.

[0037] Furthermore, for example, when the present invention is applied to an identity card, a photograph of the owner's face is used as a main image and personal information that identifies the owner is used as to-be-embedded information. The personal information may be made of fingerprints or voiceprint. Voiceprint information can be embedded in a portion of the face photograph that corresponds with the mouth.

[0038] Next, the combining step S106 of FIG. 1 will be described in more detail with reference to FIG. 6.

[0039] The main image 102 is image information in which additional information is to be embedded and, in the case of an identity card, corresponds to an owner's face photograph. The image information has 24 bits of information per pixel (8 bits for each of R, G and B components). The to-be-embedded image 105 is a bilevel image obtained by converting additional information through the previously described technique and, in the case of an identity card, corresponds to an identification number by way of example. This information has one bit of information per pixel. The mask image 103 is image information used in the combining process and the embedded image recovery process and has one bit of information per pixel.

[0040] First, a smoothing process is performed in step S301 with black pixels in the to-be-embedded image 105 as 1s and white pixels as 0s. Here, a region of 3 × 1 pixels composed of a pixel of interest and two pixels on both sides of that pixel in the x direction is cut out, and the weighted mean is taken as follows:

$$W(i) = (STL(i-1) + 2 \cdot STL(i) + STL(i+1))/4 \qquad (1)$$

where

W(i) = the weighted mean of the i-th pixel
STL(i) = embedded image at the i-th pixel (1 or 0).

[0041] Attention must be given to the fact that, unless the to-be-embedded image is enlarged by a factor of n at the creation time as described in connection with FIG. 5, it is destroyed during the smoothing process. The larger the enlargement factor, the more the factor of safety of to-be-embedded image increases. However, as the enlargement factor increases, information that should be hidden becomes easier to be revealed.

[0042] For example, when a to-be-embedded additional image is as shown in FIG. 8, the results of the smoothing process will be as shown in FIG. 9. In these figures, the enlargement factor n is set to n = 4, so that the image is enlarged by a factor of 4 in the vertical and horizontal dimensions. To leave a margin for embedding, each pair of two adjacent pixels on the periphery is set to 0s as shown in FIG. 8.

[0043] Next, in phase modulation step S302, on the basis of the results of the smoothing process in step S301, phase modulation is performed on the mask image 103 in accordance with the following rules:

$$\text{If } W(i) = 0, \text{ then } DES(i) = MSK(i) \qquad (2\text{-}1)$$

$$\text{If } W(i) = 1, \text{ then } DES(i) = MSK(i+2) \qquad (2\text{-}2)$$

[0049] The results for red component when all the pixel values of the main image 102 are 127, i.e., when (R, G, B) = (127, 127, 127), are shown in FIG. 12. Each pixel value takes an integer in the range of 0 to 255. The red component has the maximum value of 255. In this figure, the (0, 0) pixel and the (1, 0) pixel each have a value of 79, and the (2, 0) pixel and the (3, 0) pixel each have a value of 175. That is, in an area where no additional image is embedded, two successive pixels in which there is little red component and two successive pixels in which the red component is rich alternate

[0050] As can be seen from equations (3-1) to (3-3) or (3-4) to (3-6), the color difference amount for red component is opposite in sign to those for green and blue components. Therefore, in a pixel in which the red component prevails, the green and blue components are reduced. In a pixel in which the red component is reduced, on the other hand, the other color components are increased. Green plus blue (i.e., cyan) is the complement of red. Thus, even if red and cyan are located adjacent to each other, they are difficult to recognize by human eyes and looks achromatic. Since red-rich pixels and cyan-rich pixels are alternated in units of two pixels, the human visual system cannot recognize the difference in color between pixels and hence will determine that the color difference amount is 0.

[0051] In terms of the human visual system, for example, equation (4-1) will be mistakenly taken to be

$$DESR(i) = SRCR(i) \tag{5}$$

[0052] That is, humans cannot perceive the fact that additional image information has been embedded. It is on this principle that a composite image can be produced in which additional image information is embedded in a main image in a state of invisibility

[0053] A composite image is usually recorded on an electronic medium in a general-purpose imaging format, such as JPEG, TIFF, or the like However, in this embodiment, since to-be-embedded information does not depend on any imaging format, not only presently available imaging formats but also formats that will be developed in future can be employed

[0054] A method of recovering embedded information from a composite image and reproducing it will be described hereinafter

[0055] In the case of distribution via an electronic medium such as a home page on the Internet or electronic mail, the contents of a composite image are recorded on the electronic medium in such a form as shown in FIG. 12. To recover this image, the mask image 103 shown in FIG. 7 is used. The pixels of the mask image 103 are made to correspond one for one with the pixels of the composite image 107. The composite image is made effective in areas in which the mask image 103 takes a value of 1 or ineffective in areas in which the mask image pixels have a value of 0. The results are shown in FIG. 13. In this figure, shaded pixels are ineffective ones. The effective data pixels (shown unshaded) are cut out in a predetermined size.

[0056] In FIG 8, the enlargement factor, n, is set such that n = 4 and the embedded information is quadrupled. After the removal of pixels on the periphery provided for a margin for embedding, effective data is cut out in units of 4 × 4 pixels. If all the effective data pixels in a 4 × 4 pixel area take a red-rich value (175 in this example), then the embedded image in this area is made 1. If, on the other hand, they take a cyan-rich value (79 in this example), then the embedded image is made 0. When the effective data area contains both red-rich pixels and cyan-rich pixels, the embedded image depends on the pixels which are larger in number. For example, if the red-rich pixels are larger in number than the cyan-rich pixels, then the embedded image is made 1; otherwise, the embedded image is made 0. That both the red-rich pixels and the cyan-rich pixels are contained is attributed to the smoothing step in the combining process.

[0057] The results of recovery of the embedded image by this method are shown in FIG. 14. In this figure, portions enclosed by bold lines corresponds to the embedded image and matches with that of FIG. 8. It thus will be seen that the embedded information can be recovered completely. Furthermore, by reversing the procedure of creating the embedded image described in conjunction with FIG. 2, the embedded information can be reproduced.

[0058] When a composite image is printed on a non-electronic medium, such as paper, with a color printer, the same method can be used to recover an embedded image. In this case, the non-electronic medium printed with the composite image is read by an optical reader and digitization is then performed to obtain the state of FIG. 12. After that, the embedded information is simply recovered by the same method as described above.

[0059] After printing at a resolution of 400 dpi by means of a thermal printer in accordance with this embodiment and reading at a resolution of 1200 dpi by means of an optical scanner, recovery was made successfully.

[0060] In order to reproduce additional information from a non-electronic medium, another method of reproduction can be used by which a mask sheet is physically superimposed on the composite image, which has the transmission factor distribution of the same pattern as the mask image 103 and is produced at the same recording resolution as that at the time of recording a composite image. This method has an advantage of requiring no troublesome operations and complex equipment in recovering embedded information.

[0061] There is shown in FIG. 15 an embodiment in which copyright information and narration and associated background music (BGM) are embedded in, for example, a landscape photograph as the main image 102. A to-be-embed-

the embedded image to be identified visually.

[0073] Next, a description will be given of an image information processing device for implementing the image information processing method described so far. The processing device is constructed roughly from an image creating and recording device which creates and records a composite image on either an electronic medium or a non-electronic medium, and an image reproducing device which reproduces an embedded image from the composite image recorded on the electronic or non-electronic medium.

[0074] First, the image creating and recording device will be described with reference to FIG. 18. A CPU (central processing unit) 401 performs the overall control of the device. A ROM (read-only memory) 402 stores programs that the CPU 401 executes to control the operation of the entire device. A RAM (random access memory) 403 serves as a working memory of the CPU 401. An image memory 404 stores image information when images are combined and is used when processes are performed which will be described later.

[0075] A to-be-embedded image is divided into fixed information and fluid information. The fixed information includes serial numbers inherent in a system and so on, whereas the fluid information includes the date and time of processing, identification numbers, voice, etc. The fixed information and the fluid information are entered from a to-be-embedded image ROM 409 and a to-be-embedded image input unit 410, respectively, into a to-be-embedded image creation unit 408. A to-be-embedded image is created in accordance with the procedure shown in FIG. 2 and then stored in the image memory 404.

[0076] A main image 102, such as a photograph of the face of a person or a landscape photograph, is entered from a main image input unit 407 into a separate area of the image memory 404.

[0077] As instructed by an operator, the CPU 401 operates a smoothing unit 411 to perform a smoothing process on the to-be-embedded image stored in the image memory 404 and then sends the results to a phase modulation unit 412.

[0078] The phase modulation unit 412 performs a phase modulation process as shown in FIG. 11 on the basis of the results of the smoothing process and a mask image 103 from a mask image ROM 405 and then sends the results to a color difference modulation unit 413.

[0079] The color difference modulation unit 413 performs a color difference modulation process as shown in FIG. 11 on the basis of the results of the phase modulation process and color difference amount information from a color difference amount ROM 406 and then passes the results to a superimposition processing unit 414.

[0080] The superimposition processing unit 414 performs a superimposition process on the results of the color difference modulation and the main image 102 stored in the image memory 404 to produce a composite image 107 and stores it into the image memory 404.

[0081] When the composite image 107 is distributed via an electronic medium, it is distributed from a composite image output unit (electronic medium) 415 via a network by way of example. In the case of distribution via a non-electronic medium, the composite image is output from a composite image output unit (non-electronic medium) 416 composed of a printer driver and a color printer. That is, the composite image 417 (107) is output in printed form.

[0082] The image reproducing device will be described next with reference to FIG. 19. A CPU 501 performs the overall control of the device. A ROM 502 stores programs that the CPU 501 carries out to control of the operation of the entire device. A RAM 503 is used as a working memory of the CPU 501. An image memory 504 stores image information when embedded information is recovered and is used for processes which will be described later.

[0083] A composite image 507 (107) recorded on a non-electronic medium, such as paper, is read by a composite image reader 506 and then converted into digital data, which is in turn stored in an image memory 504. The composite image reader includes an optical scanner and its driver.

[0084] A composite image recorded on an electronic medium is directly stored into the image memory 504. The alignment marks M as shown in FIG. 16 are read out at the same time the composite image 507 is read and then stored in the RAM 503.

[0085] As instructed by the operator, the CPU 501 controls each unit to recover the embedded information.

[0086] The mask image creation unit 508 identifies the type of the mask image from the alignment mark information stored in the RAM 503, takes out of the mask image ROM 505 a mask information necessary for recovery and reproduction of the embedded image, creates mask image, and stores it into the image memory 504.

[0087] An embedded image visualization unit 509 for making visible the embedded image superimposes the mask image 103 and the composite image 507 (107) upon each other as illustrated in FIGS. 7 and 8 and extracts only the effective data of the embedded image, thereby visualizing the embedded image. After that, an embedded image reproduction unit 510 performs the procedure which is the reverse of that of FIG. 2, thereby reproducing the embedded information.

[0088] As described so far, according to this embodiment, a composite image in which additional information is superimposed on a main image can be created irrespective of which of electronic and non-electronic media it is to be recorded on. In addition, irrespective of the type of a recording medium used, the composite image can be recorded and added image information can be reproduced.

[0089] Therefore, multimedia contents, such as electronic picture books, picture mail, sounding pictures, and so on,

degrades as the security strength increases.

[0106] In the third embodiment, by sharing a role between the face photograph image for identifying the person himself or herself and the face photograph image for security, the image quality and the security strength can be made compatible with each other.

[0107] The photograph image 5 on the last page 3 appears to human eyes as a black and white image; however, since it is composed of three primary colors of R, G, and B (or C, M, and Y), it, like the photographic image 4 on the first page, can be printed out by a usual color printer. That is, the apparatus can be used in common, which is very economical.

[0108] Although, in the third embodiment, two types of images, the identification image and the security image, are used, they do not necessarily need to be printed on the first page and the last page. If, in the identity card, there exists a page which is very secure, for example, a watermarked page, the security image can be printed on that page to further increase the security.

[0109] In the third embodiment, which uses the image information processing method of the second embodiment, the security strength and the image quality are not compatible with each other as described previously. Thus, the image quality degrades as the security strength increases. Hereinafter, causes of the degradation of image quality will be discussed.

[0110] As described previously, composite image data are expressed by

$$DESR(i) = VR(i) + SRCR(i) \quad (4\text{-}1)$$

$$DESG(i) = VG(i) + SRCG(i) \quad (4\text{-}2)$$

$$DESB(i) = VB(i) + SRCB(i) \quad (4\text{-}3)$$

where

DESR(i) = result of superimposition at the i-th pixel for the red component (an integer in the range of 0 to 255)
DESG(i) = result of superimposition at the i-th pixel for the green component (an integer in the range of 0 to 255)
DESB(i) = result of superimposition at the i-th pixel for the blue component (an integer in the range of 0 to 255)
SRCR(i) = main image at the i-th pixel for the red component (an integer in the range of 0 to 255)
SRCG(i) = main image at the i-th pixel for the green component (an integer in the range of 0 to 255)
SRCB(i) = main image at the i-th pixel for the blue component (an integer in the range of 0 to 255).

[0111] Note that DESR(i), DESG(i) and DESB(i) each take an integer in the range of 0 to 255. For example, when VR(i) = 48 and SRCR(i) = 240, DESR(i) = 48 + 240 = 288, exceeding 255. In practice, when 255 is exceeded, an overflow results, so that 38 by which the result exceeds 255 is thrown away. Properly speaking, with DESR(i) = 288, the embedded image should have well balanced with the composite image, so that it is placed in a state of invisibility. However, since DESR(i) is limited to 255 as a result of overflow, the embedded image (security information) becomes visible.

[0112] This is the cause of the degradation of quality of the composite image. In order to minimize the degradation, it is required to decrease the color difference amount ΔV so that the overflow is minimized. However, the security strength lowers as ΔV decreases. Although the case of overflow has been described so far, the same phenomenon also occurs with underflow in which DESR(i) is less than 0.

[0113] In the previously-described image information processing method of the second embodiment, the color difference amount ΔV is fixed at Vo regardless of SRC (indicating data values of the embedded image) shown on the vertical axis as shown in FIG. 23A.

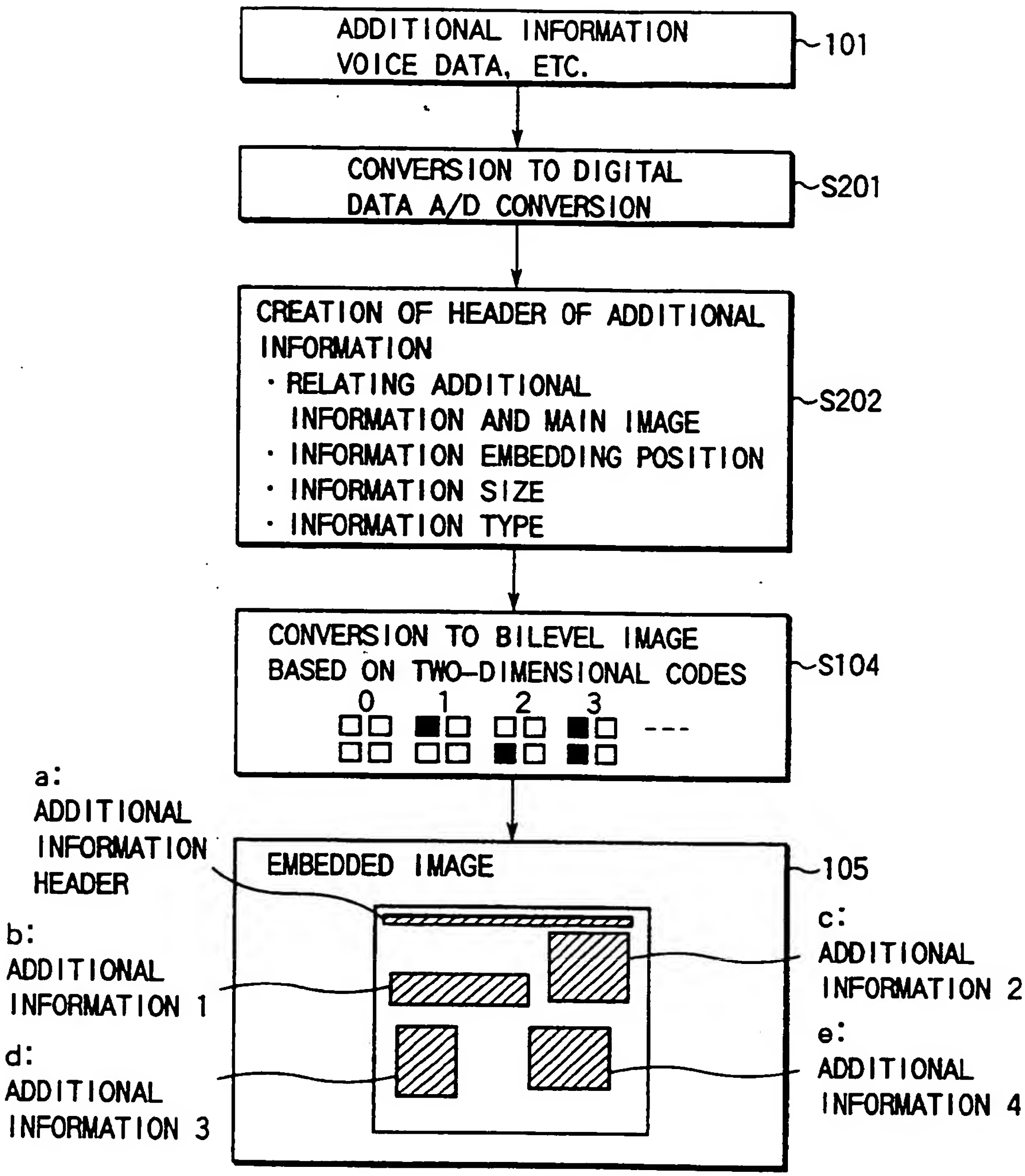
[0114] By establishing a trapezoid relationship between ΔV and SRC as shown in FIG. 23B, that is, by making ΔV vary with the embedded image data value in a region close to 0 where underflow is likely to occur and in a region close to 255 where overflow is likely to occur, underflow or overflow is made difficult to occur. This improves balance between the composite image and the embedded image, allowing the image quality of the composite image to be improved with the security strength maintained.

[0115] In this case as well, however, there arises the problem that, when the main image data value is just 0 or 255, no embedding is performed.

[0116] These problems can be circumvented by setting a minimum color difference amount Vmin as shown in FIG. 23C. Strictly speaking, overflow or underflow will occur when the color difference amount is at Vmin. Thus, the image quality degrades in comparison with the case of FIG. 23A; however, this level of degradation is out of the question as compared with the case of FIG. 23A. By setting Vmin to Vo/2 on an experience basis, the image quality of the composite image and the strength of security can be made compatible with each other.

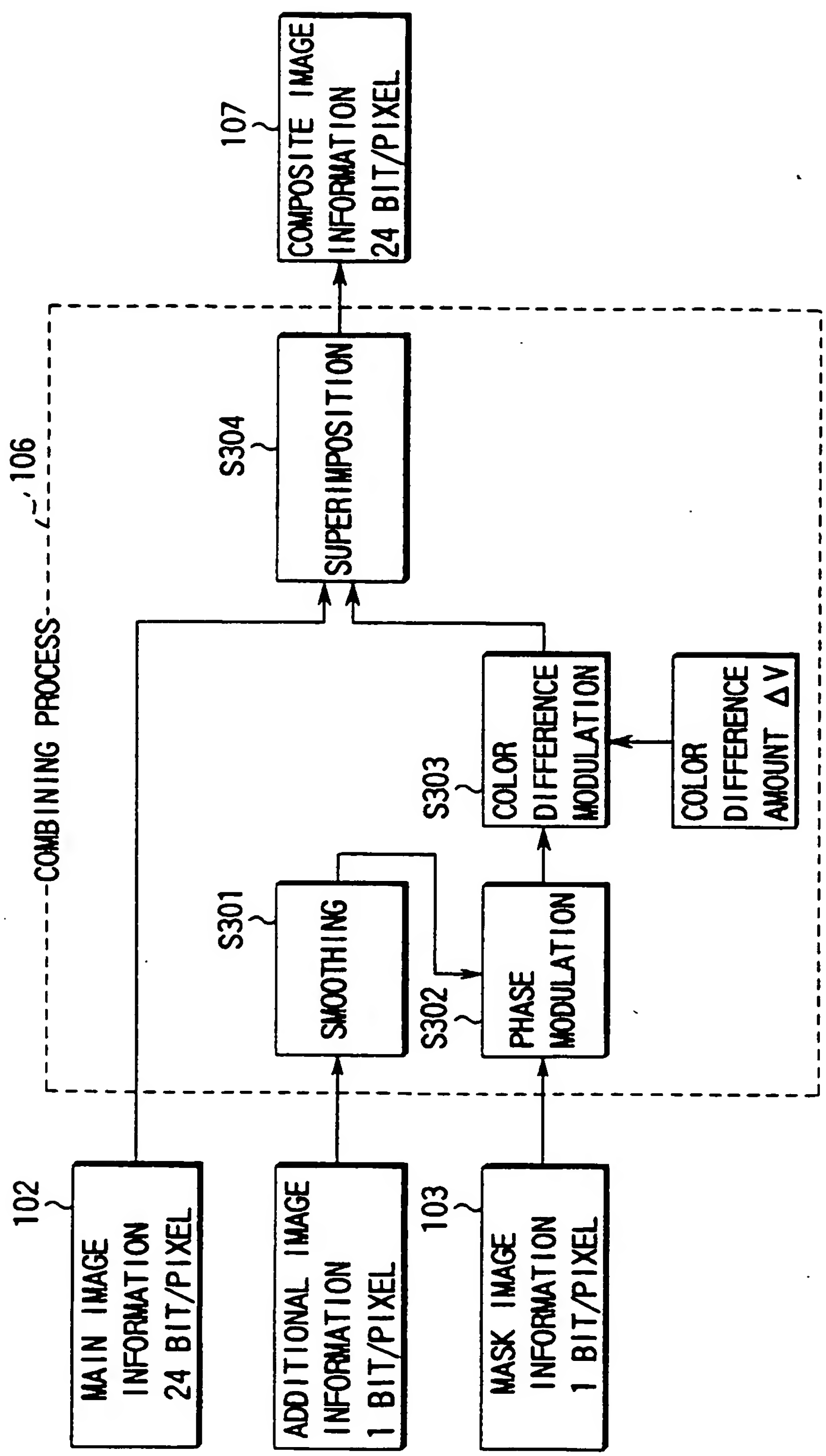
[0117] As described so far, according to the second and third embodiments of the present invention, an image infor-

and its respective pixel is composed of multiple color components; and recording the composite image on a recording medium.


ADDITIONAL INFORMATION
VOICE DATA, ETC.
101
CONVERSION TO DIGITAL
DATA A/D CONVERSION
S201
CREATION OF HEADER OF ADDITIONAL INFORMATION
· RELATING ADDITIONAL INFORMATION AND MAIN IMAGE
· INFORMATION EMBEDDING POSITION
· INFORMATION SIZE
· INFORMATION TYPE
S202
CONVERSION TO BILEVEL IMAGE
BASED ON TWO-DIMENSIONAL CODES
0
1
2
3

S104
a:
ADDITIONAL
INFORMATION
HEADER
EMBEDDED IMAGE
105
b:
ADDITIONAL
INFORMATION 1
c:
ADDITIONAL
INFORMATION 2
d:
ADDITIONAL
INFORMATION 3
e:
ADDITIONAL
INFORMATION 4

FIG. 2



102
MAIN IMAGE INFORMATION 24 BIT/PIXEL
ADDITIONAL IMAGE INFORMATION 1 BIT/PIXEL
103
MASK IMAGE INFORMATION 1 BIT/PIXEL
COMBINING PROCESS
106
S301
SMOOTHING
S302
PHASE MODULATION
S303
COLOR DIFFERENCE MODULATION
COLOR DIFFERENCE AMOUNT ΔV
S304
SUPERIMPOSITION
107
COMPOSITE IMAGE INFORMATION 24 BIT/PIXEL

FIG. 6

ADDITIONAL IMAGE (STL)

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	1	1	1	1	0	0	0	0	1	1	1	1	0	0
3	0	0	1	1	1	1	0	0	0	0	1	1	1	1	0	0
4	0	0	1	1	1	1	0	0	0	0	1	1	1	1	0	0
5	0	0	1	1	1	1	0	0	0	0	1	1	1	1	0	0
6	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0
7	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0
8	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0
9	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

FIG. 8

RESULTS OF PHASE MODULATION (DES)

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0
1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1
2	1	1	0	1	0	0	0	0	1	1	0	1	0	0	0	0
3	0	0	1	0	1	1	1	1	0	0	1	0	1	1	1	1
4	1	1	0	1	0	0	0	0	1	1	0	1	0	0	0	0
5	0	0	1	0	1	1	1	1	0	1	1	0	1	1	1	1
6	1	1	0	0	1	1	0	1	0	0	1	1	0	0	0	0
7	0	0	1	1	0	0	1	0	1	1	0	0	1	1	1	1
8	1	1	0	0	1	1	0	1	0	0	1	1	0	0	0	0
9	0	0	1	1	0	0	1	0	1	1	0	0	1	1	1	1
10	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0
11	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1

FIG. 10

RESULTS OF SUPERIMPOSITION PROCESS RED COMPONENT (DESR)

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	79	79	175	175	79	79	175	175	79	79	175	175	79	79	175	175
1	175	175	79	79	175	175	79	79	175	175	79	79	175	175	79	79
2	79	175	175	79	175	175	175	175	79	175	175	79	175	175	175	175
3	175	79	79	175	79	79	79	79	175	79	79	175	79	79	79	79
4	79	175	175	79	175	175	175	175	79	175	175	79	175	175	175	175
5	175	79	79	175	79	79	79	79	175	79	79	175	79	79	79	79
6	79	79	175	175	79	175	175	79	175	175	79	79	175	175	175	175
7	175	175	79	79	175	79	79	175	79	79	175	175	79	79	79	79
8	79	79	175	175	79	175	175	79	175	175	79	79	175	175	175	175
9	175	175	79	79	175	79	79	175	79	79	175	175	79	79	79	79
10	79	79	175	175	79	79	175	175	79	79	175	175	79	79	175	175
11	175	175	79	79	175	175	79	79	175	175	79	79	175	175	79	79

FIG.12

RESULTS OF RECOVERY (b) RED COMPONENT

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
2	X	X	1	1	1	1	0	0	0	0	1	1	1	1	X	X
3	X	X	1	1	1	1	0	0	0	0	1	1	1	1	X	X
4	X	X	1	1	1	1	0	0	0	0	1	1	1	1	X	X
5	X	X	1	1	1	1	0	0	0	0	1	1	1	1	X	X
6	X	X	0	0	0	0	1	1	1	1	1	1	1	1	X	X
7	X	X	0	0	0	0	1	1	1	1	1	1	1	1	X	X
8	X	X	0	0	0	0	1	1	1	1	1	1	1	1	X	X
9	X	X	0	0	0	0	1	1	1	1	1	1	1	1	X	X
10	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
11	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

FIG. 14

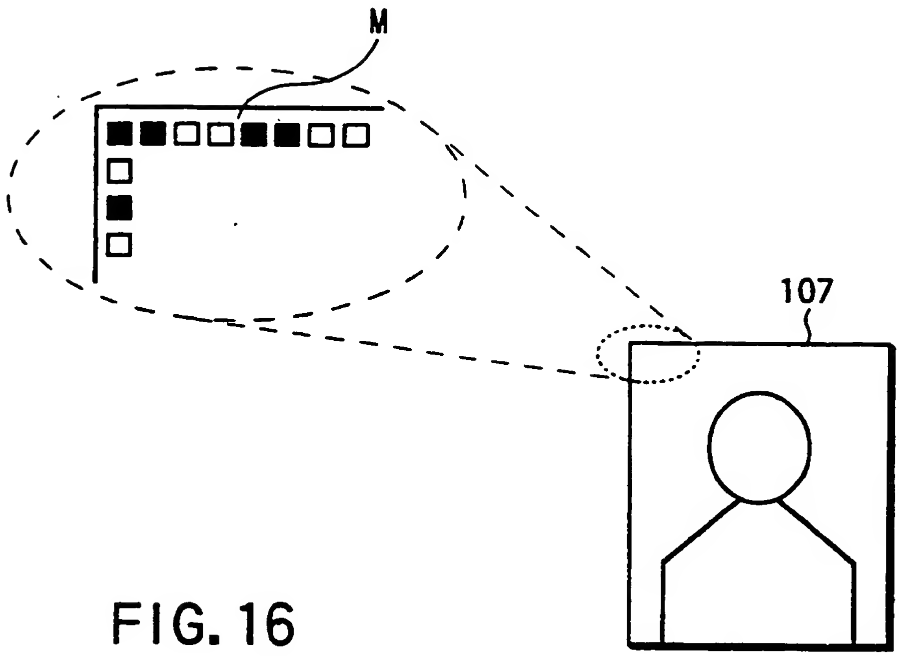
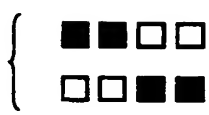


FIG. 16

FIG. 17



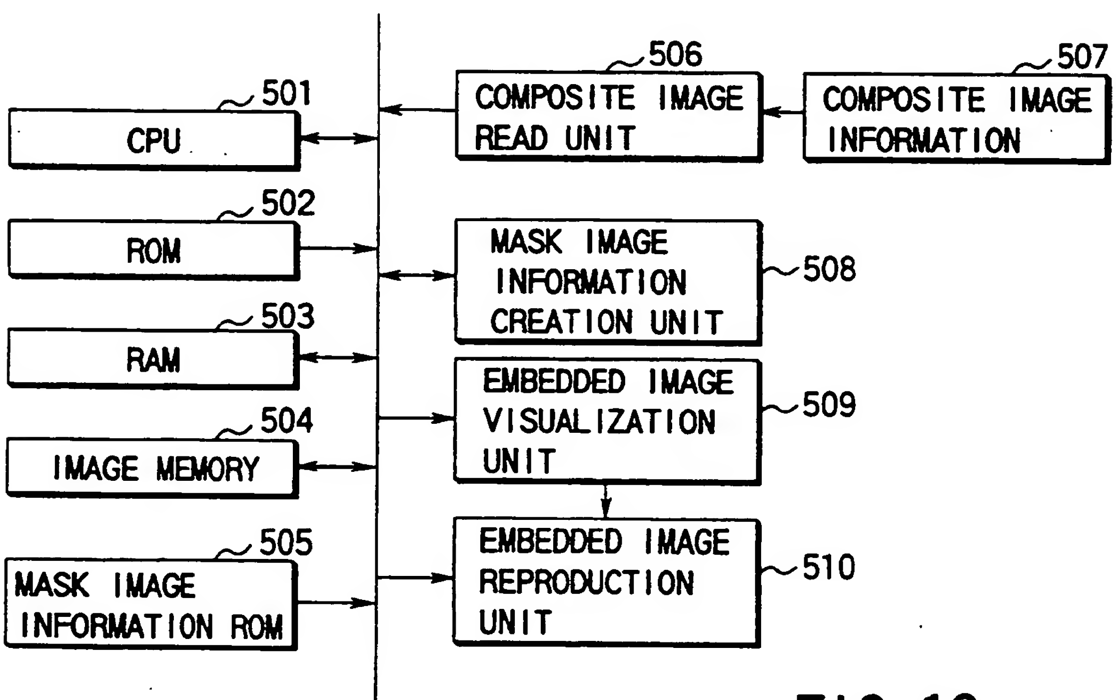


FIG. 19

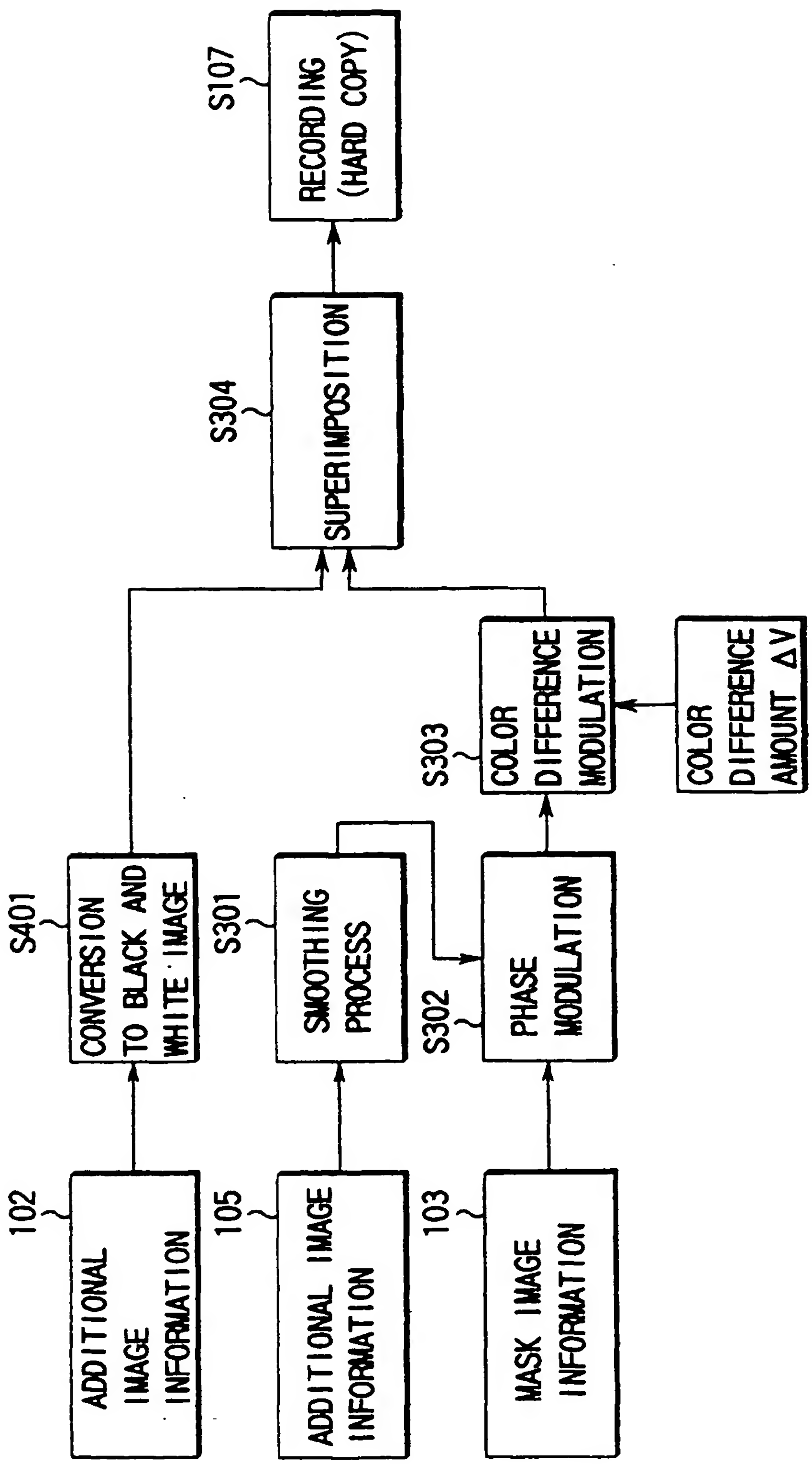

102
ADDITIONAL IMAGE INFORMATION
105
ADDITIONAL IMAGE INFORMATION
103
MASK IMAGE INFORMATION
S401
CONVERSION TO BLACK AND WHITE IMAGE
S301
SMOOTHING PROCESS
S302
PHASE MODULATION
S303
COLOR DIFFERENCE MODULATION
COLOR DIFFERENCE AMOUNT ΔV
S304
SUPERIMPOSITION
S107
RECORDING (HARD COPY)

FIG. 20

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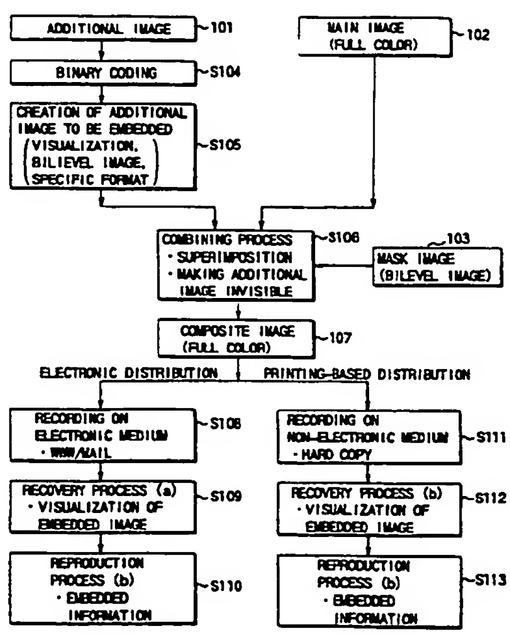

FIG. 1

EP 0 921 675 A3

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28-02-2001

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9514289 A	26-05-1995	US 5768426 A	16-06-1998
		CA 2174413 A	26-05-1995
		EP 0737387 A	16-10-1996
		EP 0959620 A	24-11-1999
		EP 0959621 A	24-11-1999
		EP 0987855 A	22-03-2000
		JP 9509795 T	30-09-1997
		US 5748763 A	05-05-1998
		US 5841978 A	24-11-1998
		US 5832119 A	03-11-1998
		US 5745604 A	28-04-1998
		US 5862260 A	19-01-1999
		US 5841886 A	24-11-1998
		US 6026193 A	15-02-2000
		US 6122392 A	19-09-2000
		US 6111954 A	29-08-2000
		US 5850481 A	15-12-1998
JP 09248935 A	22-09-1997	US 6095566 A	01-08-2000
EP 0554115 A	04-08-1993	JP 5219353 A	27-08-1993
		JP 5244389 A	21-09-1993
		CA 2088235 A	01-08-1993
		DE 69324290 D	12-05-1999
		DE 69324290 T	16-09-1999
		US 6166750 A	26-12-2000

EPO FORM P0459

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